



ThermoFisher
S C I E N T I F I C

Scios Dual Beam

Module 1

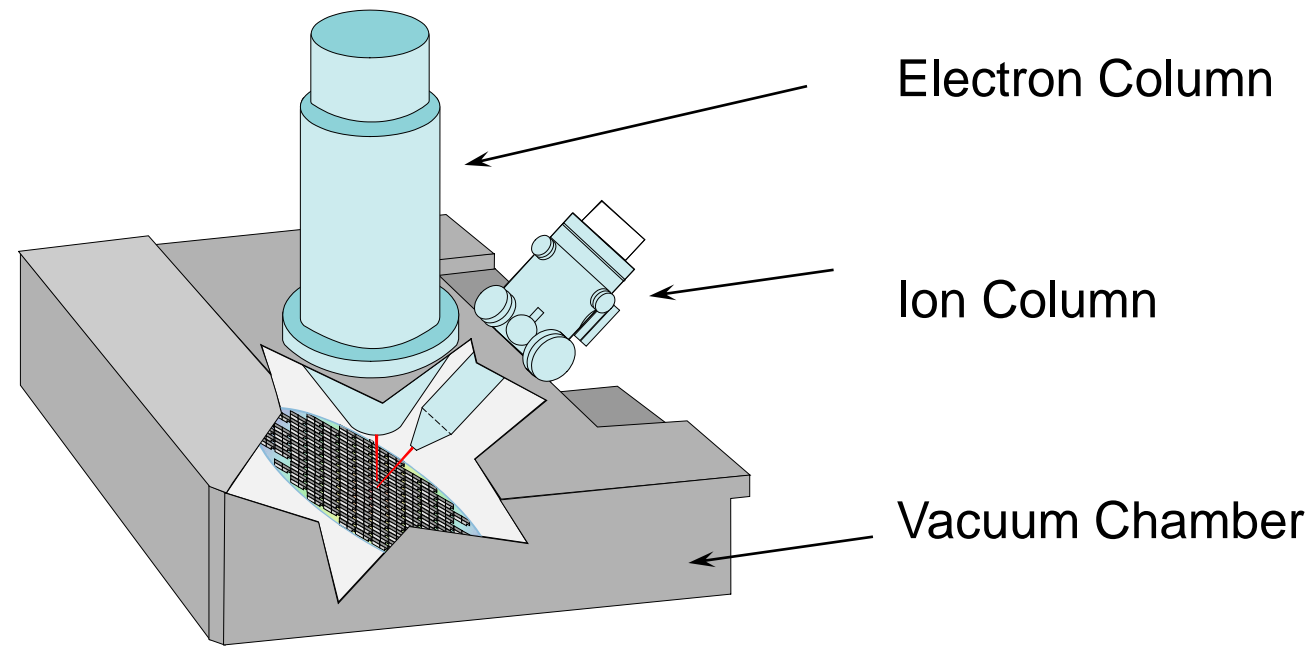
- High-Current 65 nA Ion Column (with Automated Apertures):
 - Fast milling of large areas
- Drift Suppression (DS) mode
 - Accurate milling of non-conductive material
- Large sample holder

- New NiCol e-column with Trinity detection
- High-Current FE-Column; 200 nA (with Automated Apertures):
 - Expanding High Resolution SE imaging at high and low beam currents
 - Accurate and fast milling of non-conductive material
 - Fast EDS and EBSD analysis
- Flexible Port configuration

- New LVSED: Low Vacuum SE detector:
 - Charge-free imaging of non-conductive materials

- Retractable Annular STEM 3+ detector: Bright Field, Dark Field and High Angle Dark Field
- Retractable DBS (for High Vacuum and Low Vacuum)
- T3 in column detector
- ICE: Ion Conversion and Electron detector
- EasyLift manipulator

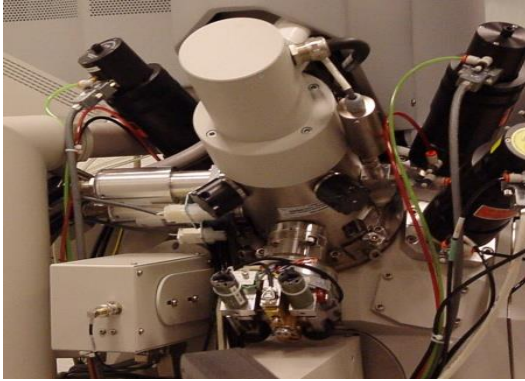
SDB = (small) Dual Beam system =
SEM and FIB Column on one system



- DualBeam system unique functions
 - Imaging with both beams
 - Slice with FIB and view with SEM (simultaneously=SPI)
 - In-situ cross sectioning, etching & coating
 - Electron beam metal deposition for protection
 - Electron beam for charge neutralization
 - Thin TEM sample preparation (<100nm) with low kV cleaning
 - Site specific sample preparation and EDS

- Imaging with both beams
 - SEM: SE imaging, BSE imaging, X-ray analyses
 - FIB: SE imaging, SI imaging, SIMS
 - Secondary ion imaging shows material contrasts
 - Channeling Contrasts with I beam (or E beam)

Flexible port configuration



4 GIS ports



EasyLift



Cryo



**Micro
Analysis**



Cooling



Heating

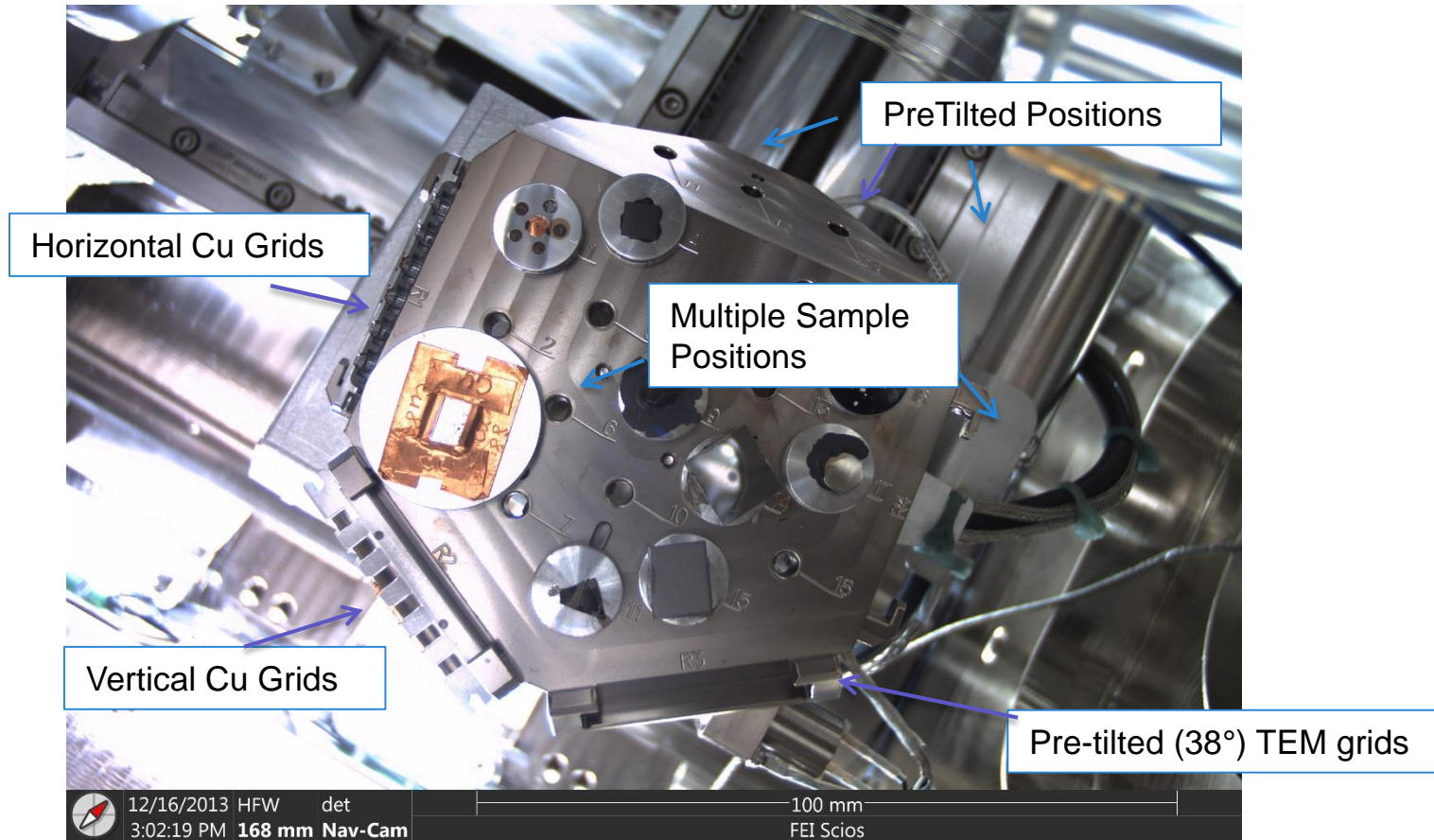


EBSD



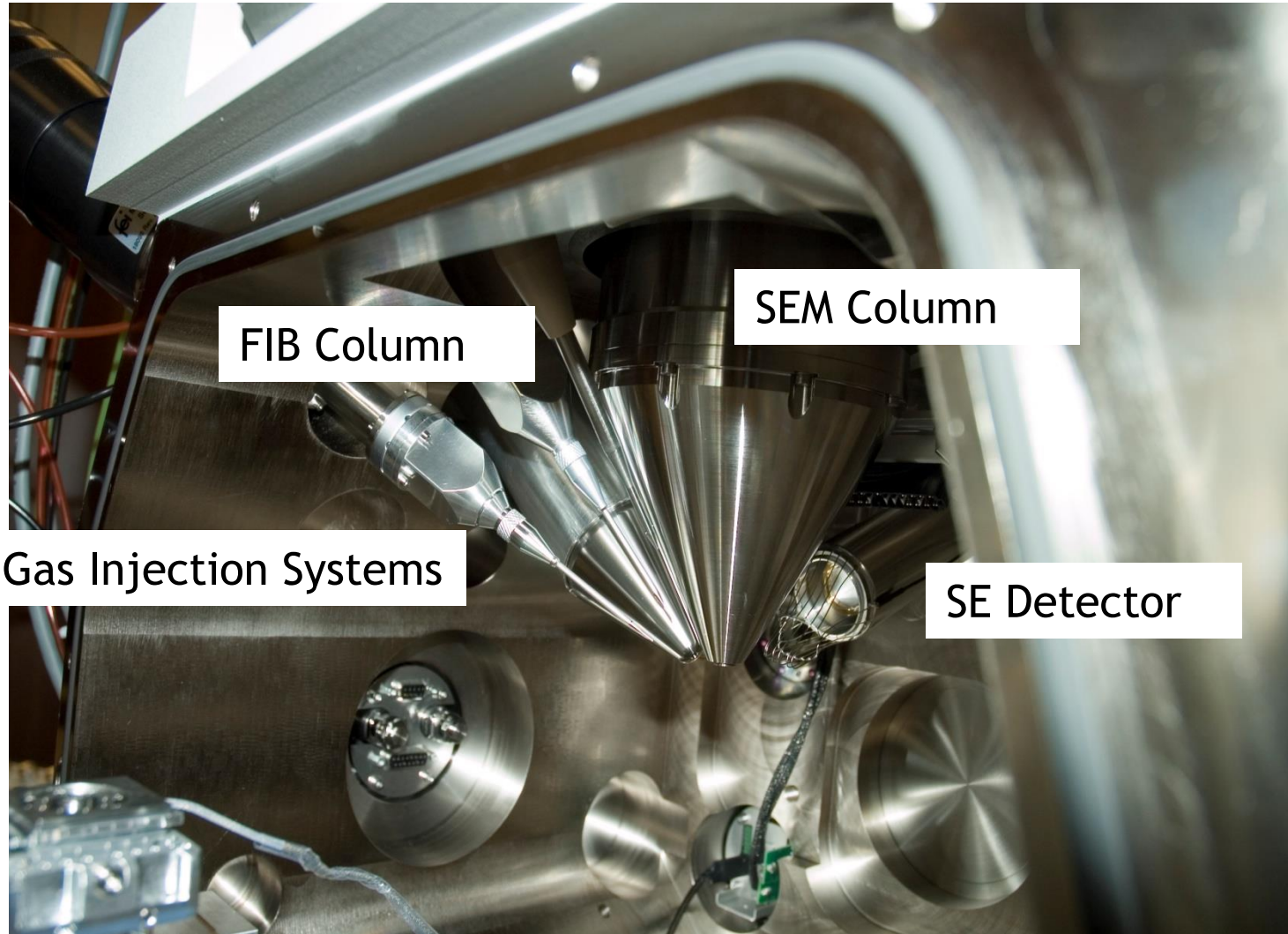
Manipulation

Large Sample holder, Multiple Options, Easy Navigation



- Multiple positions accommodate plenty of samples
- Pre-tilted sample positions for Bulk Samples
- Large Stage movement; 110mm x 110 mm X,Y, 90° tilt
- Vertical, Horizontal and Pre-tilted TEM grid holder positions
- Easy and Fast sample Location with Nav-Cam

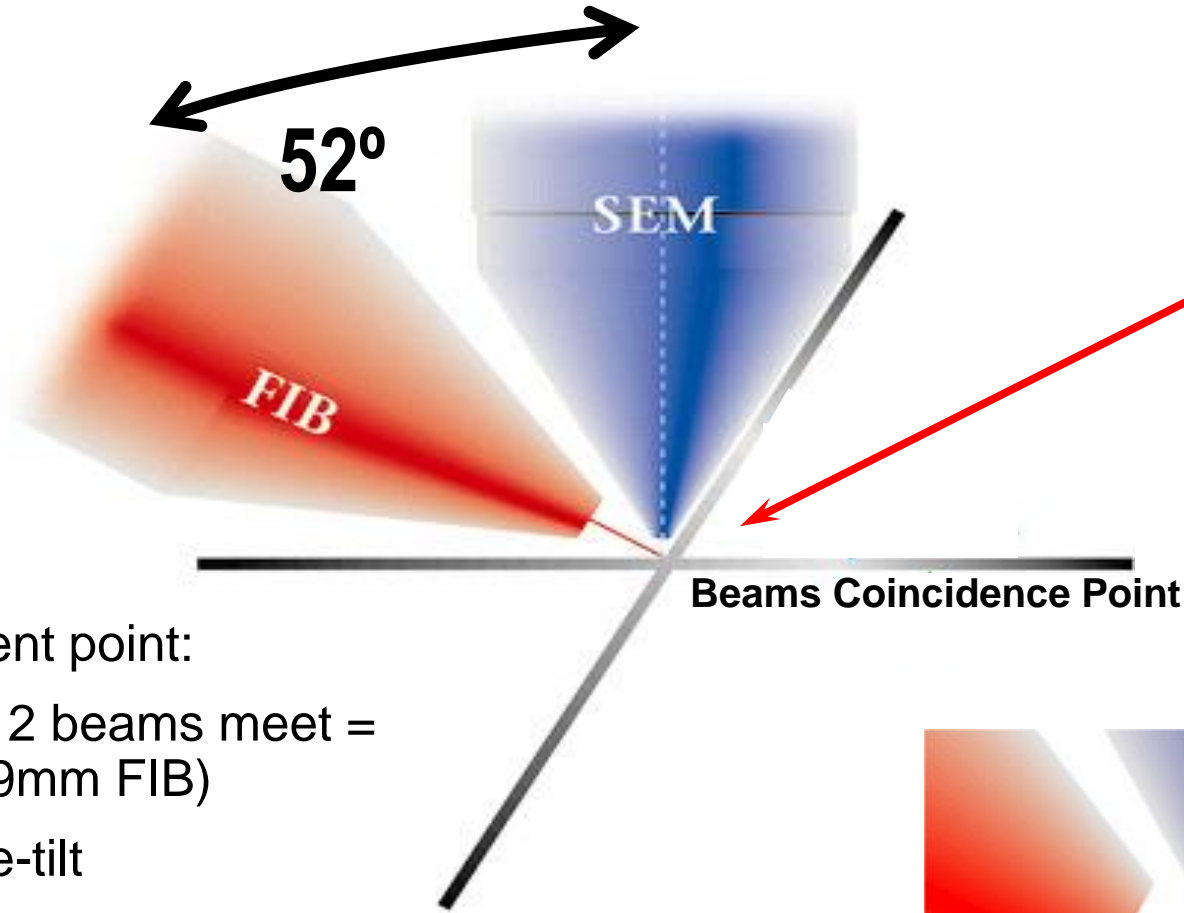
Bulk samples and pre-tilted TEM grids can be loaded simultaneously. Allowing S(TEM) sample preparation and STEM without breaking the vacuum



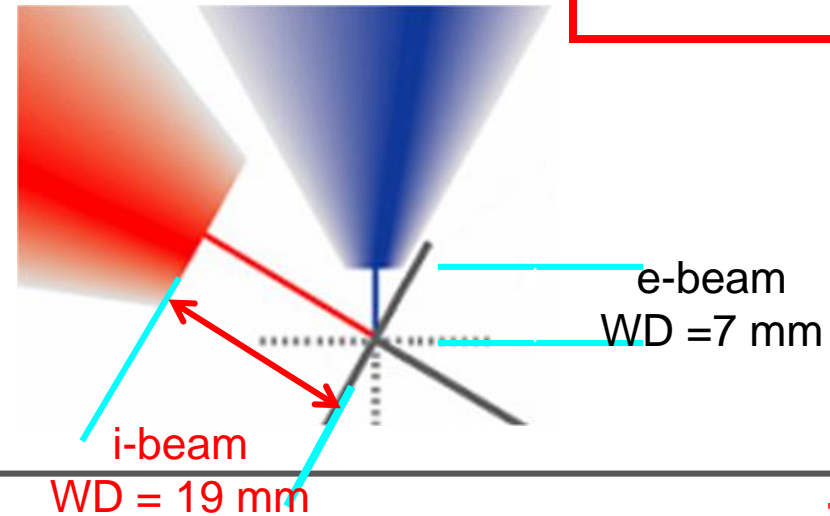
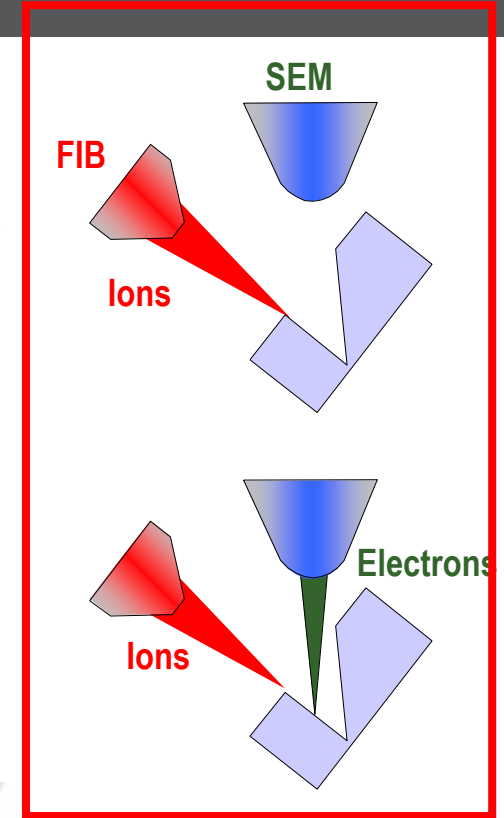
Principle of a Dual Beam

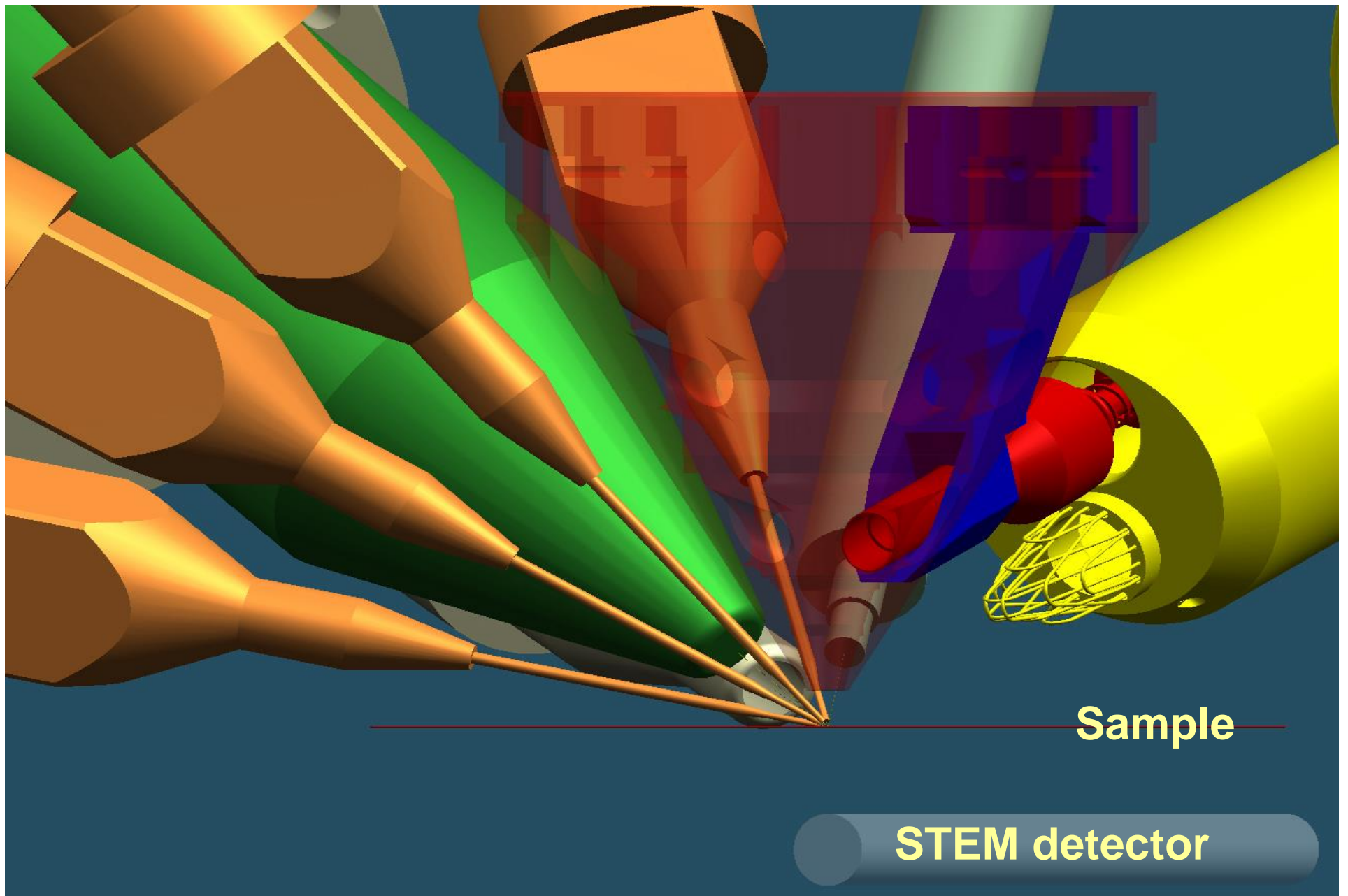


Ga LMIS



- Beam coincident point:
the point where 2 beams meet =
(7mm SEM + 19mm FIB)
- Eucentric stage-tilt
(7mm SEM)
- High-resolution imaging
- Gas Chemistry
- EDX.....





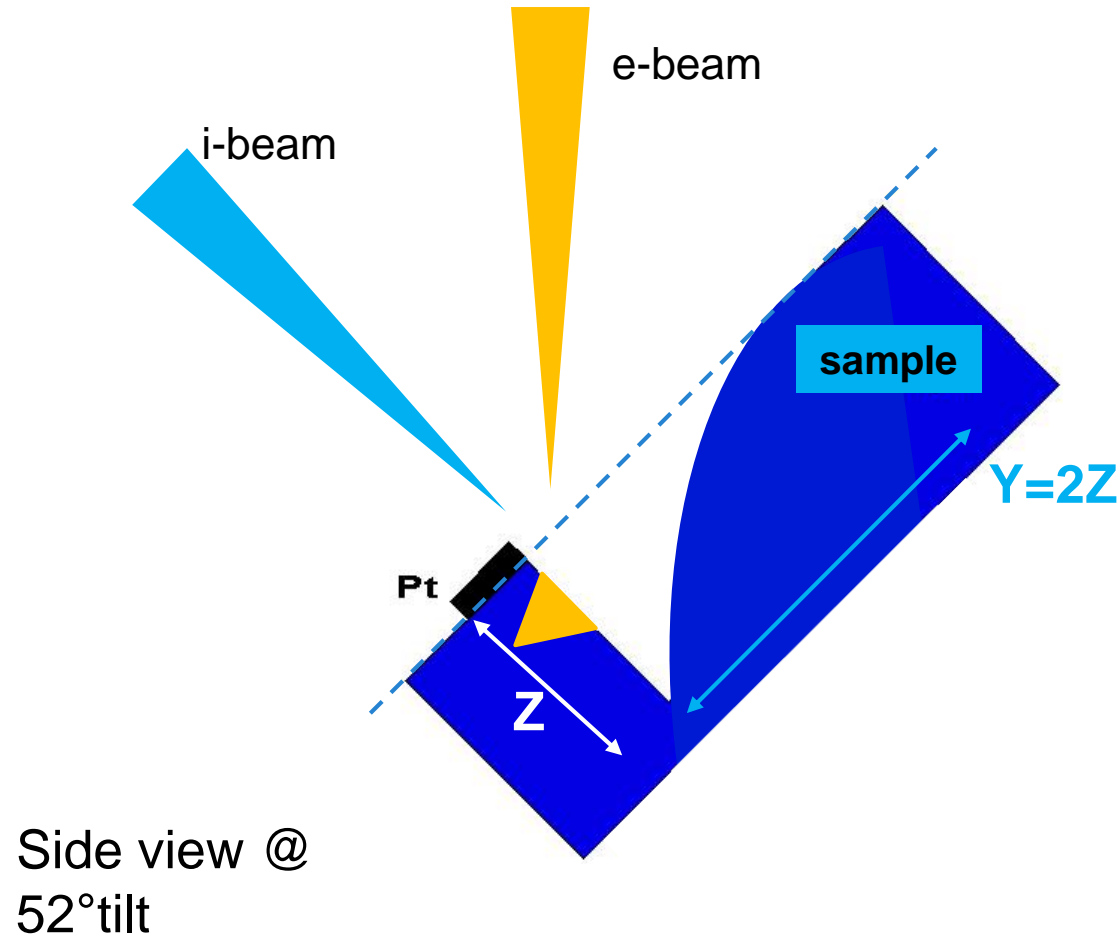
FIB

- i-beam deposition
- Adds and Removes Material: site specific
- SE imaging
- Secondary Ion imaging
- In situ sample prep
- Resolution: 5nm @ 30kV
- Combines high magnification imaging and sample modification
- Ion beam penetration:
50nm in Al @ 30kV
(6nm @ 1kV)
more surface info

SEM

- e-beam deposition
- Adds Material: site specific
- SE imaging
- BSE imaging
- X-ray analyses
- Dynamic experiments
- Better resolution:
1nm @ 30kV
- e - beam penetration:
6000nm in Al @ 30 kV
(28nm @ 1kV)

What is a Cross section ?



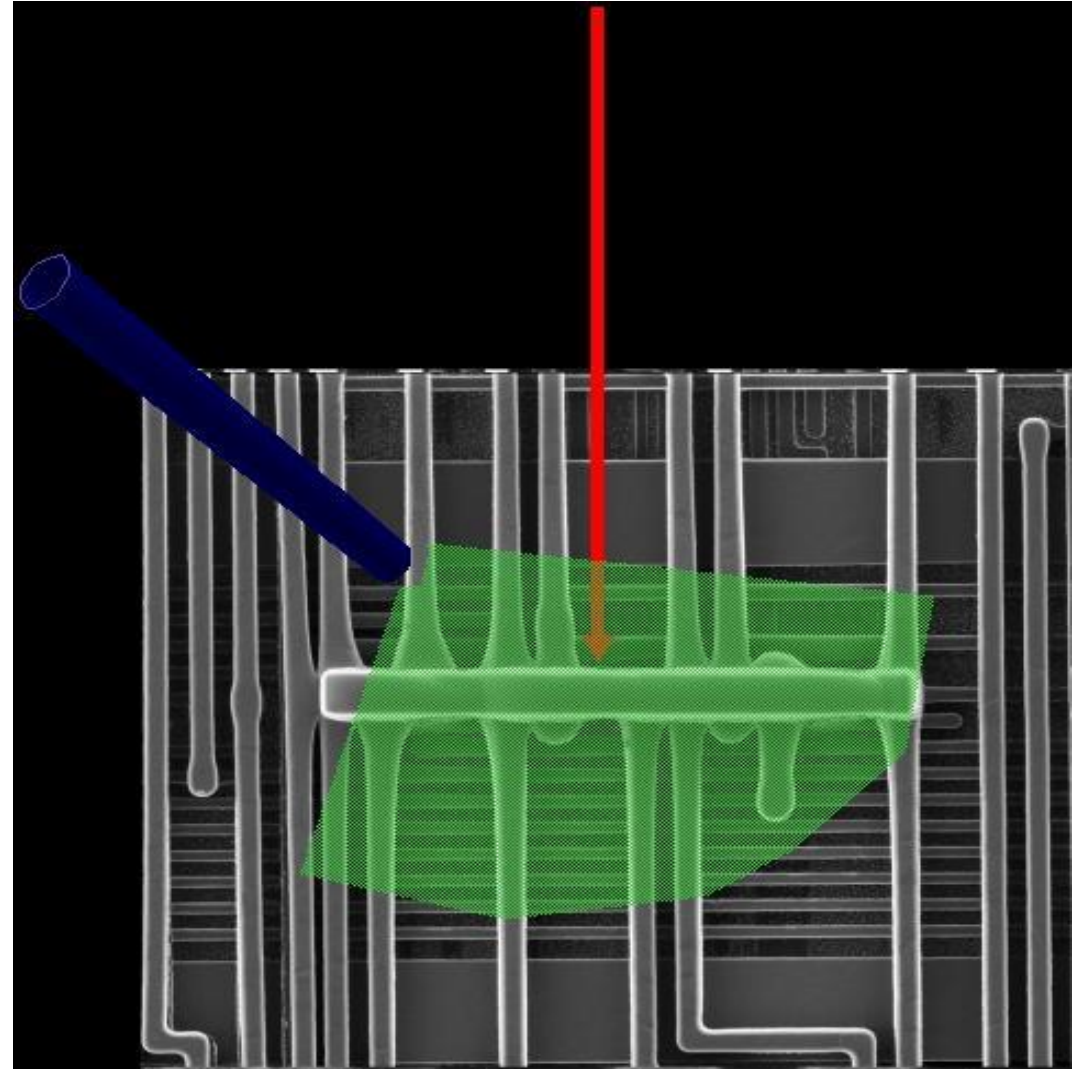
- FIB removes small amount of material leaving a perpendicular wall for imaging (with e-beam or i-beam)
- SEM takes image of revealed structures below the surface to image/measure the previously buried feature

The most commonly used ion is Gallium:

- it has the longest liquid range of any metal (from 29.8°C to 2175°C)
- providing room temperature operation
- yields a long lifetime source
- Gallium can be focused to a very fine probe size (< 10 nm in diameter)
- Liquid metal Gallium is high vacuum compatible
- large ions for physical sputtering
- (below the melting point) Gallium is a soft, silver white metal that is stable in both air and water.

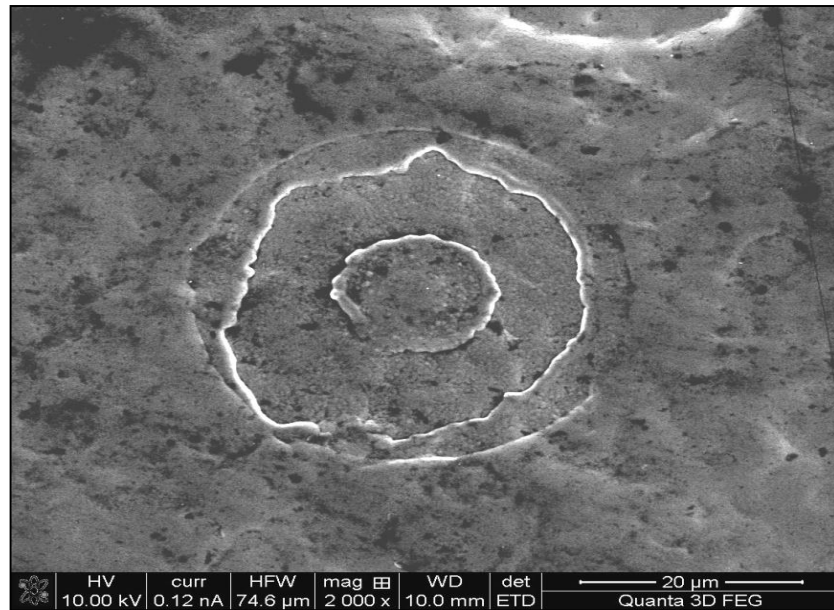
The GIS or Gas Injection system enables:

- Deposition of a metal or insulator
- FIB or SEM assisted chemical vapor deposition
- Etching chemistries, preferential or enhanced milling

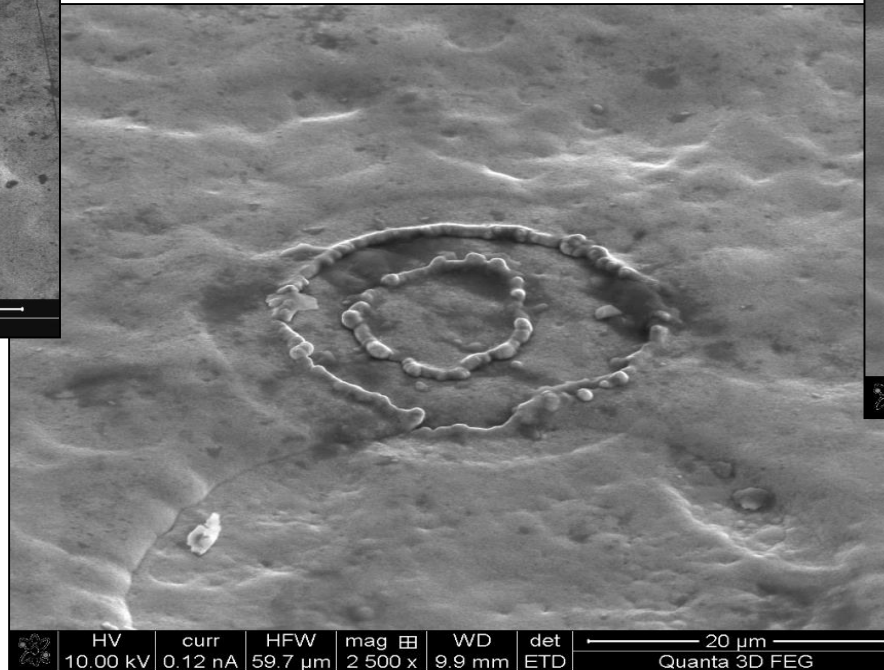


Some examples

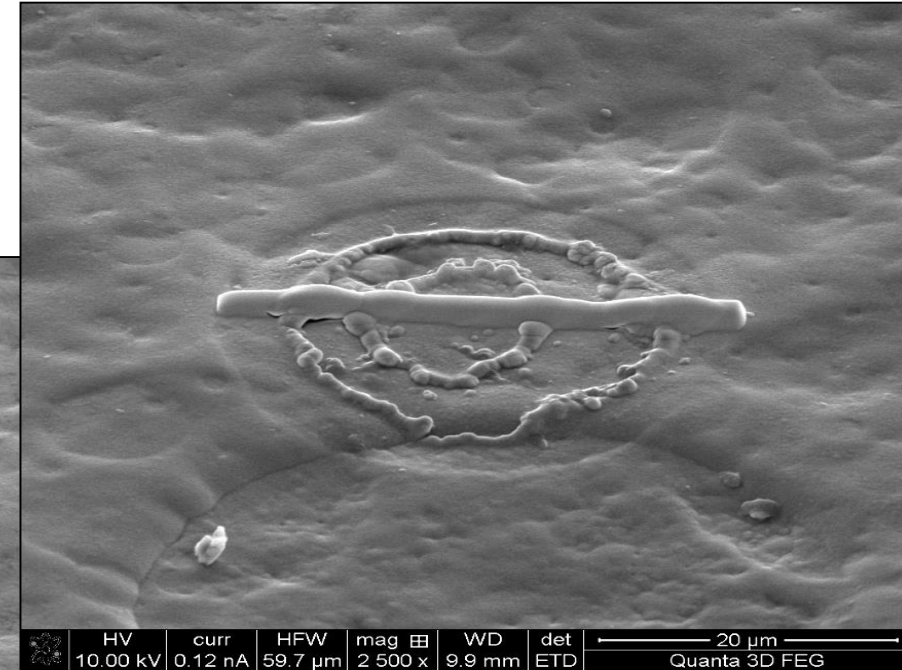
Tilt at eucentric height



E-beam top view 0°tilt

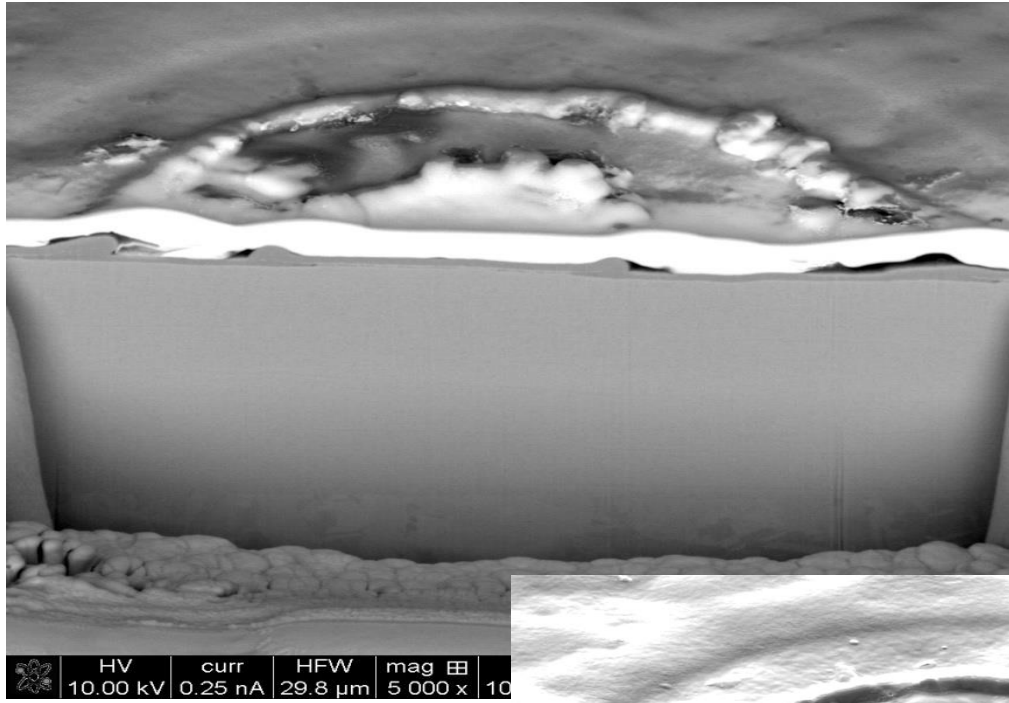


E-beam at 52°tilt

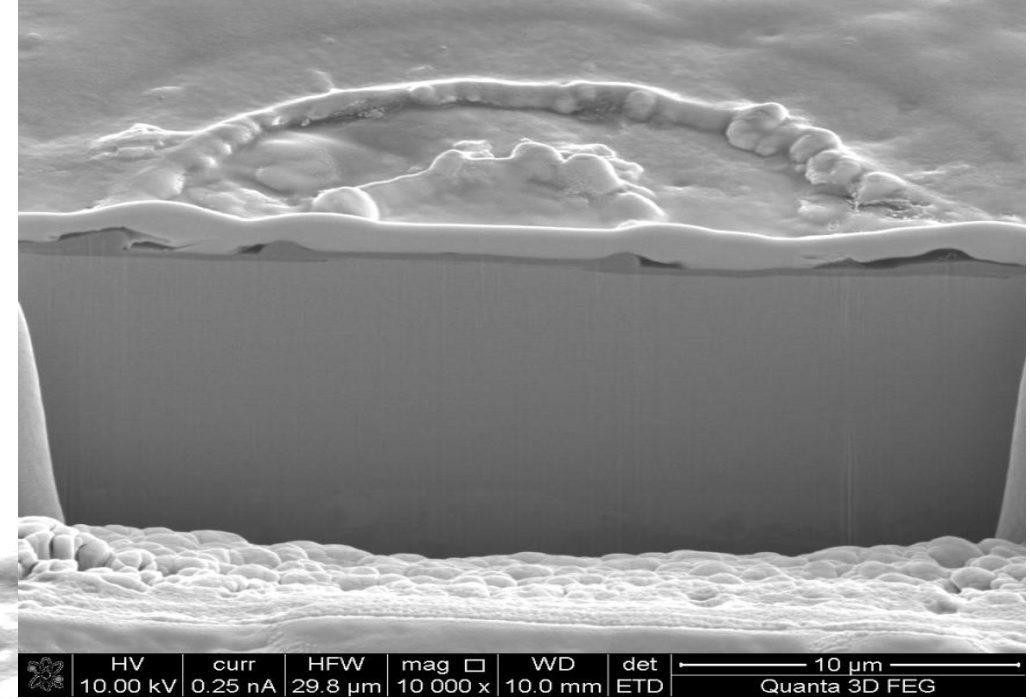


Pt deposition

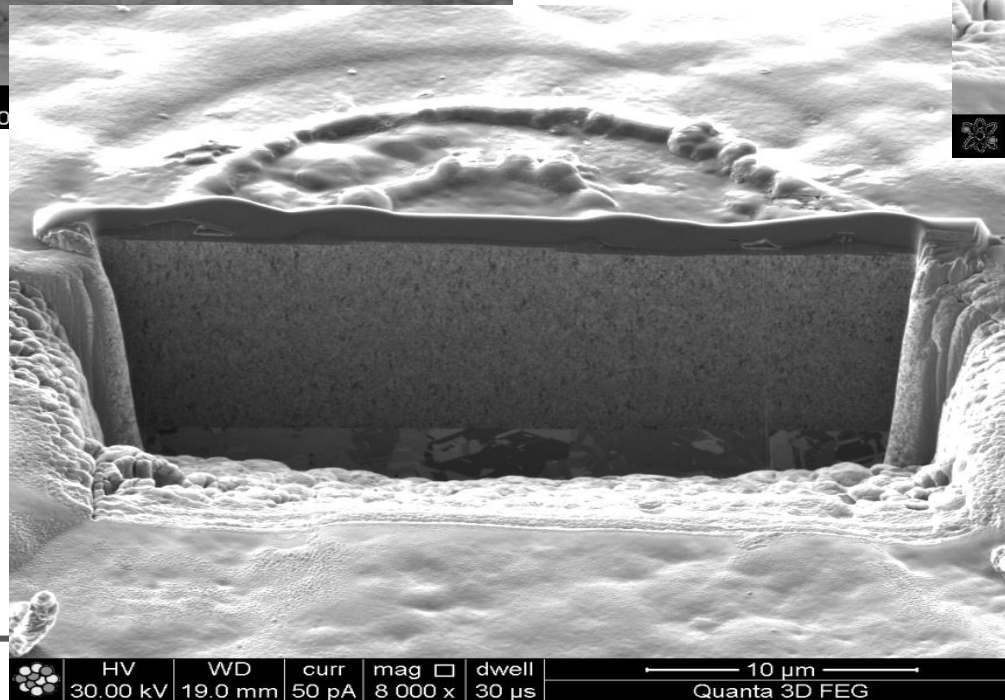
Imaging Cross section



BSE image:
compositional info

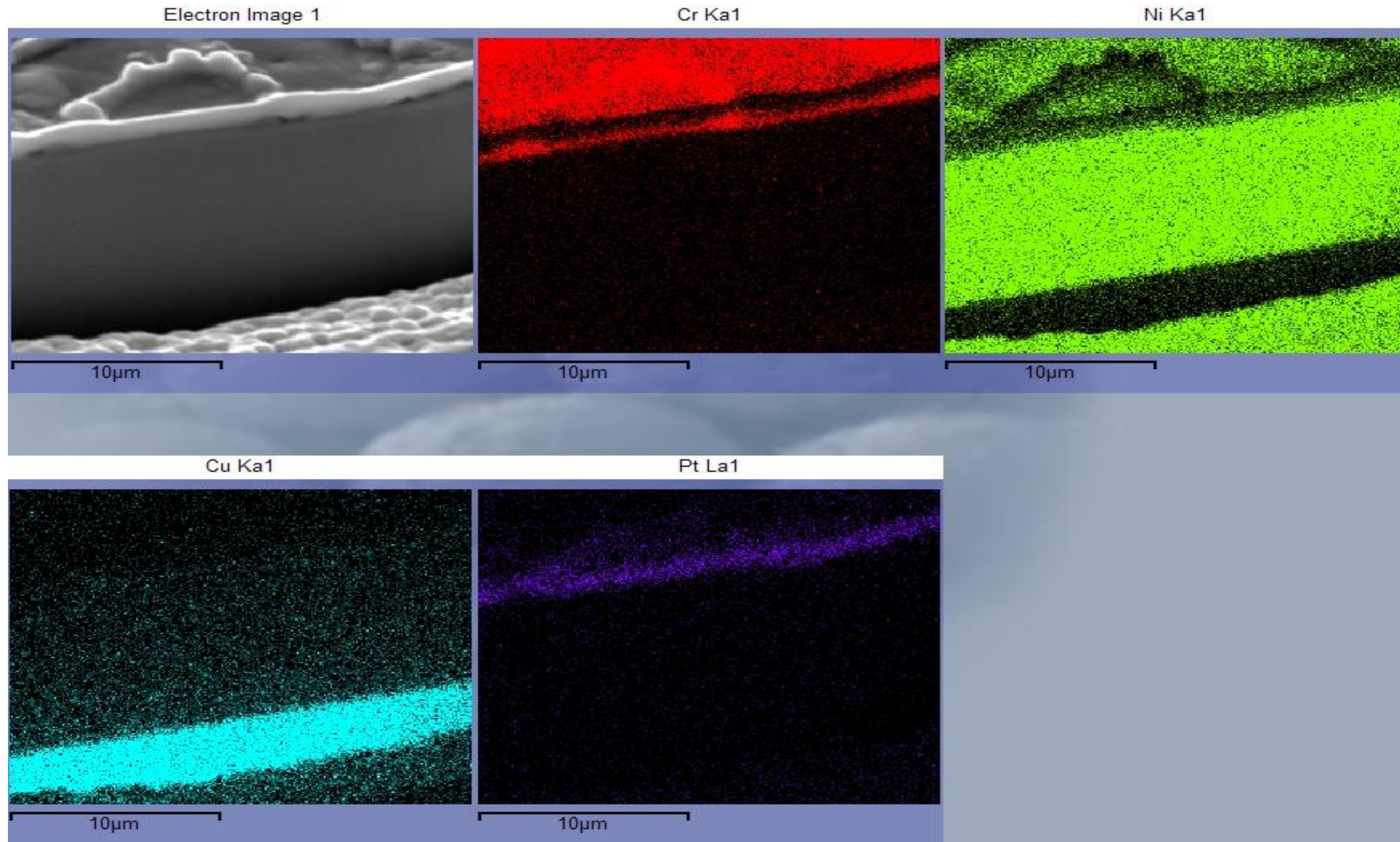


SE image:
topographical info

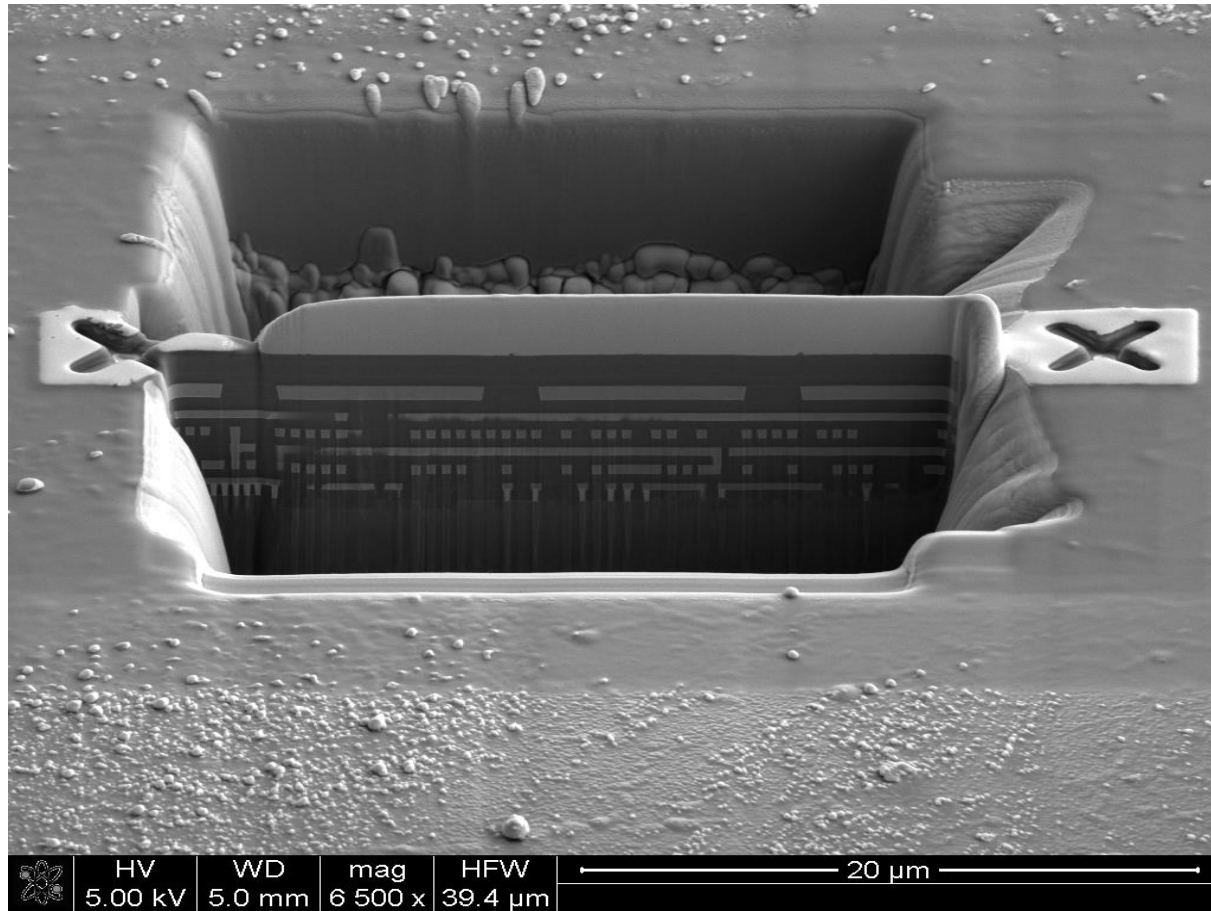


Ion induced SE image:
crystallographic orientation
contrast

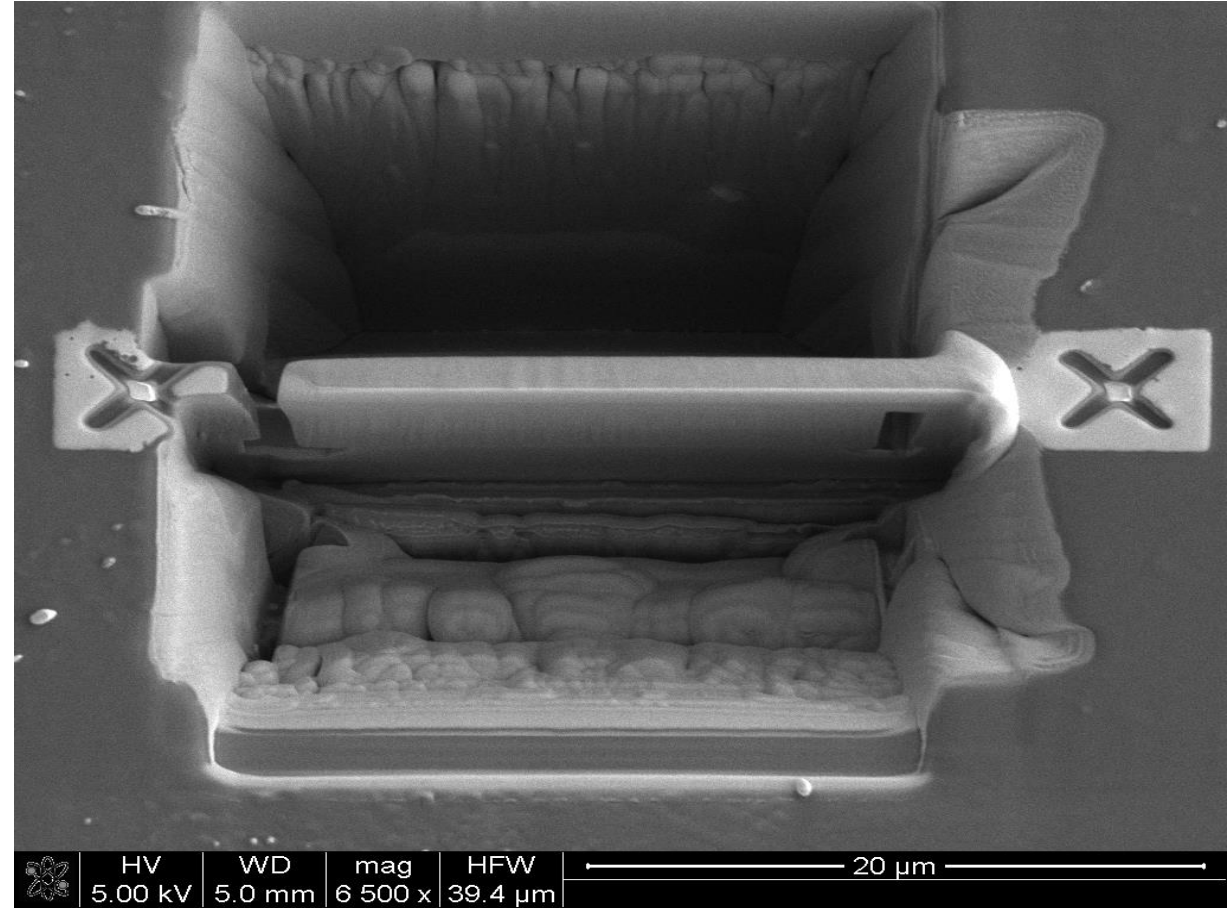
Elemental mapping of cross section



In-situ lift out TEM sample preparation



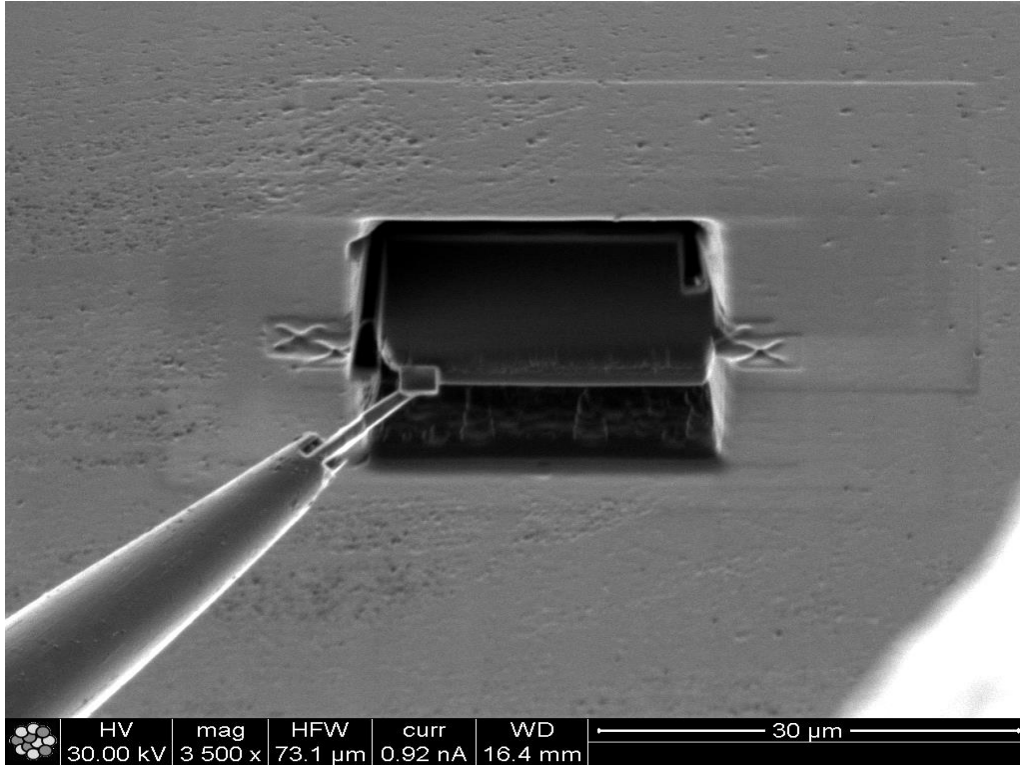
(a)



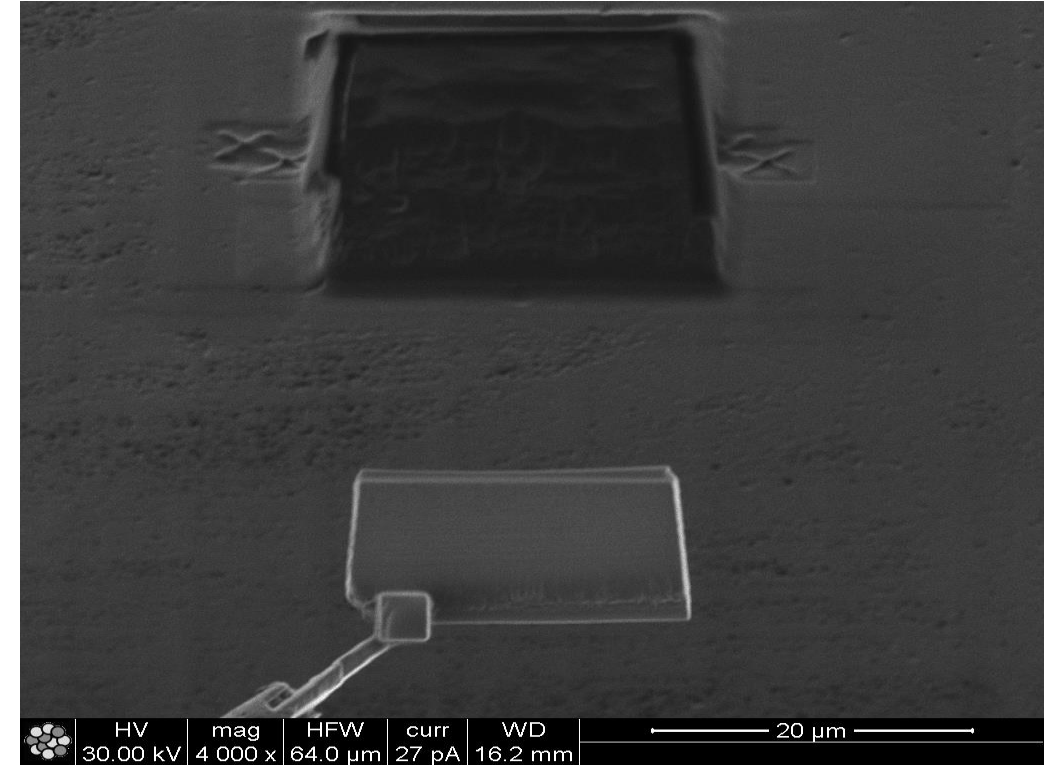
(b)

(a) Rough milled TEM specimen by FEI AutoTEM;
(b) After bottom and sides cut the specimen is ready for in-situ lift out.

In-situ lift out TEM specimen preparation



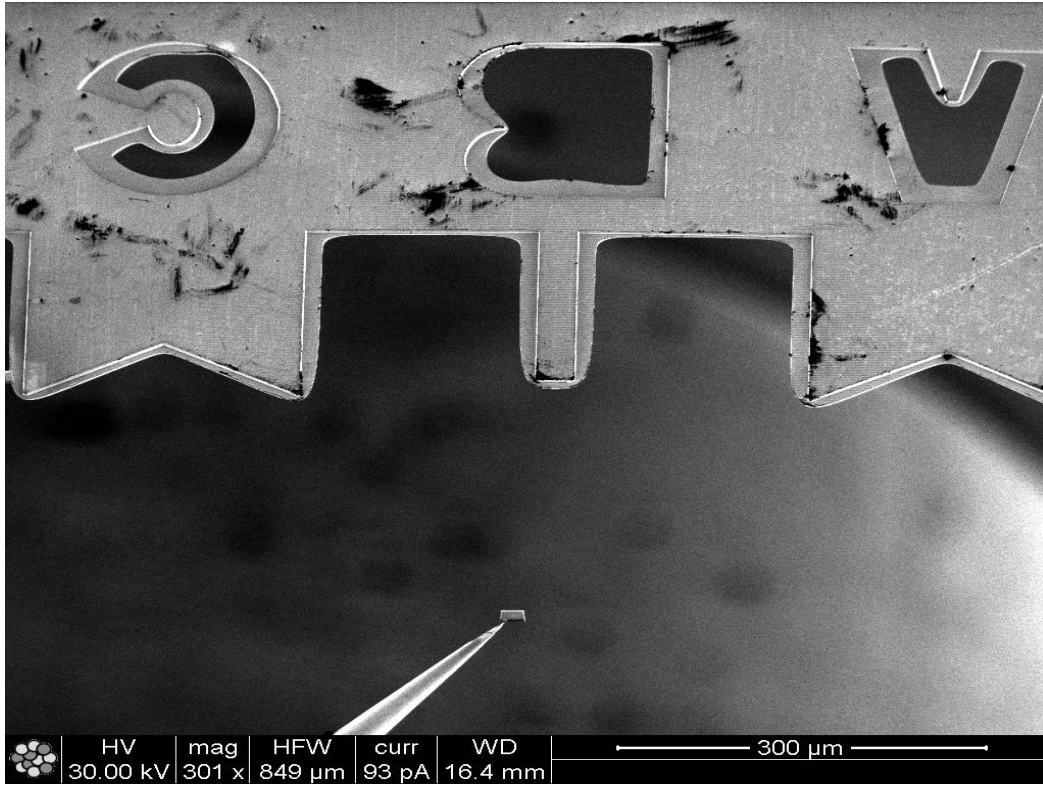
(a)



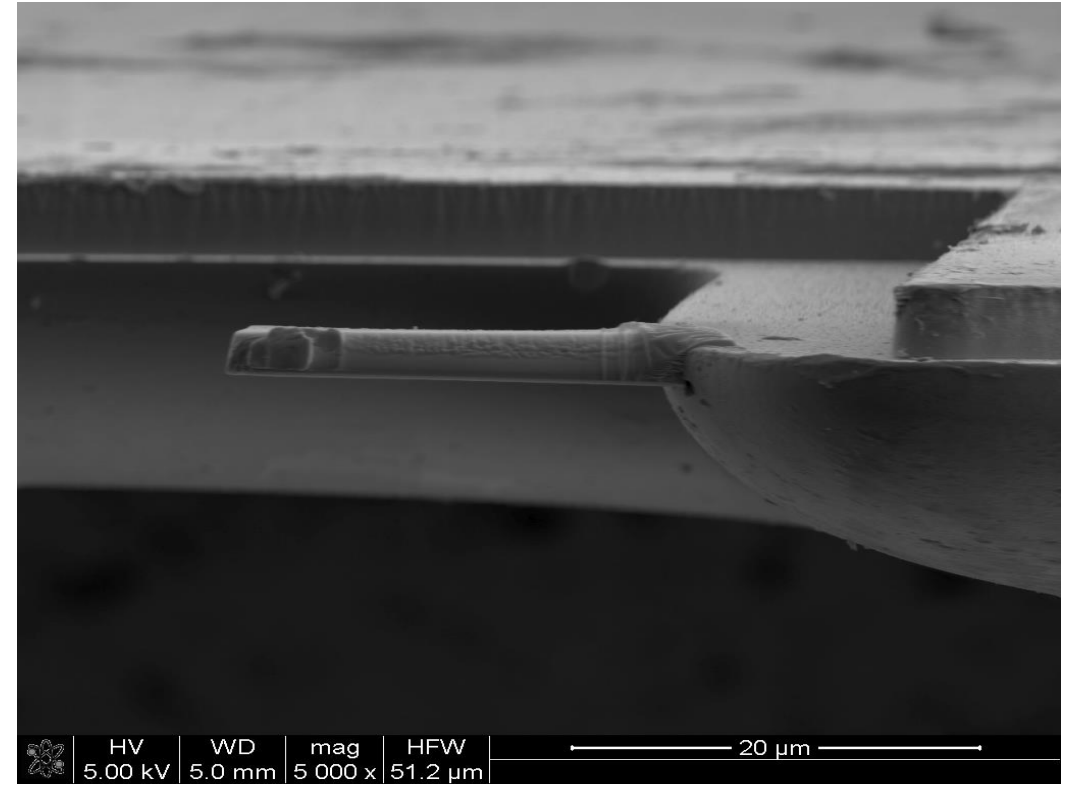
(b)

(a) In-situ lift out Probe needle connected to the specimen by ion beam Pt deposition;
(b) The specimen was cut free from the bulk material and in-situ lifted.

In-situ lift out TEM specimen preparation



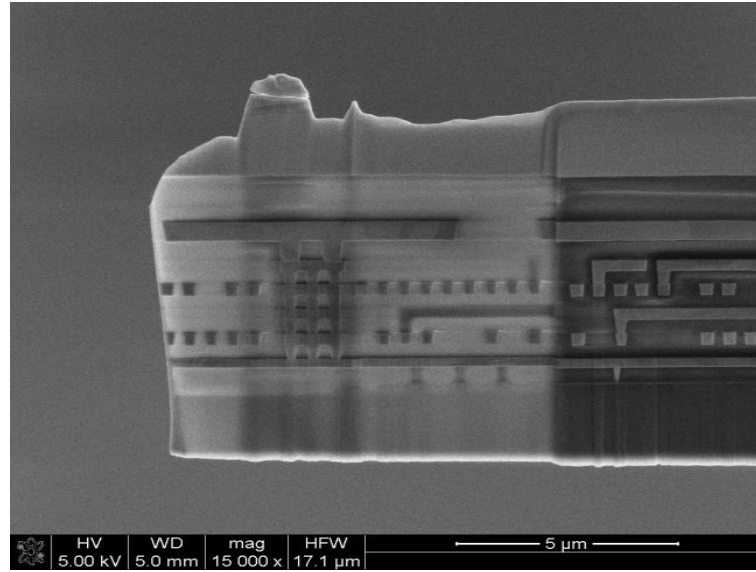
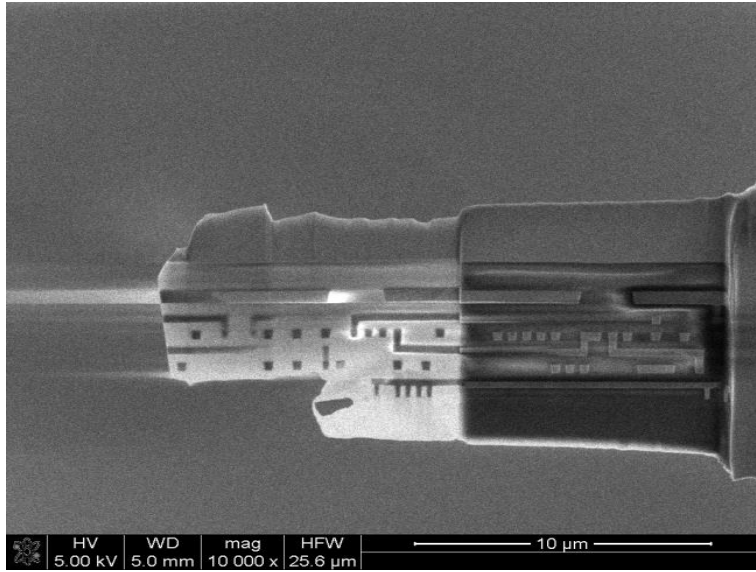
(a)



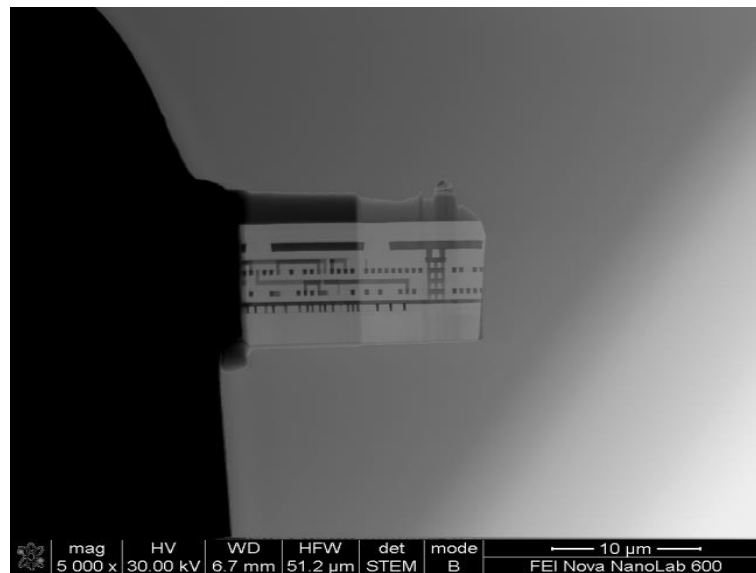
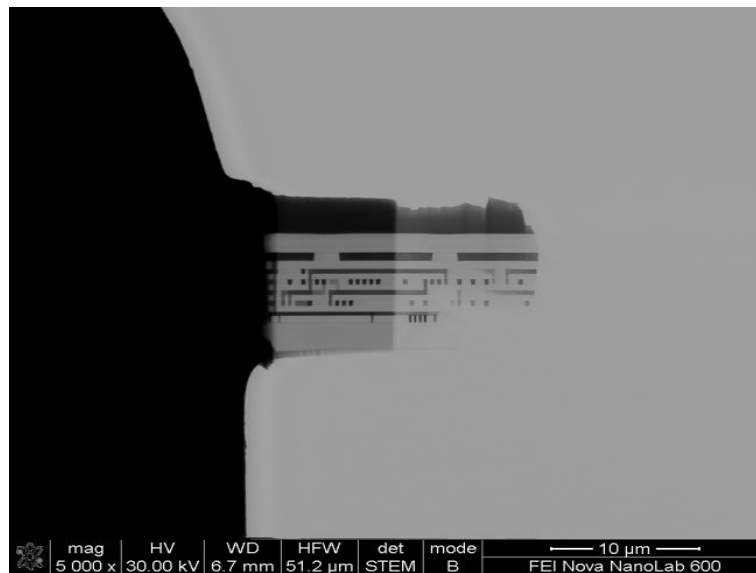
(b)

- (a) The in-situ lifted specimen transferred to a TEM grid
(b) The specimen was connected to the TEM grid by ion beam Pt deposition and the needle was cut free from the specimen.
The specimen is ready for final thinning.

Images made after final thinning



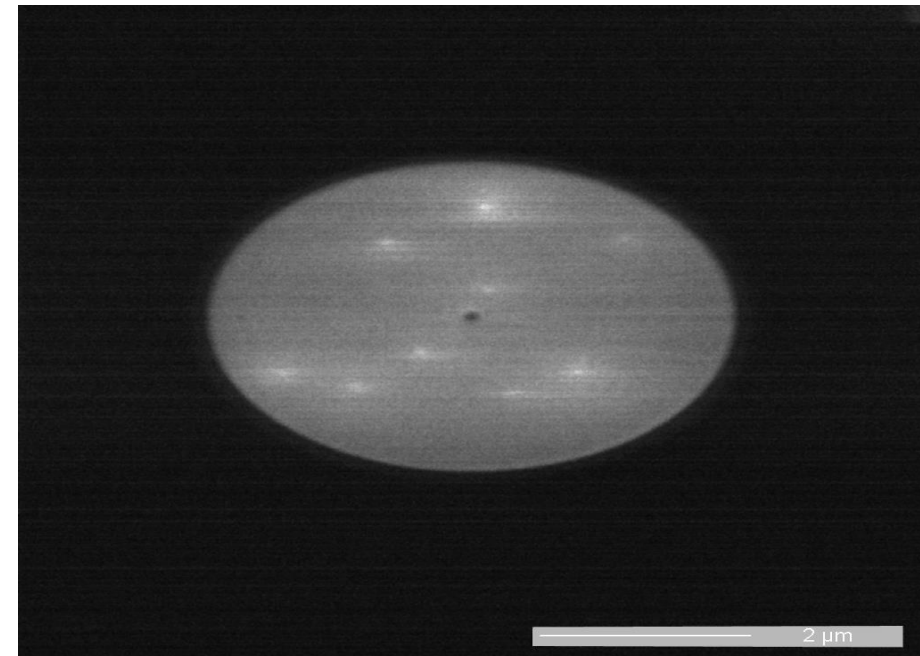
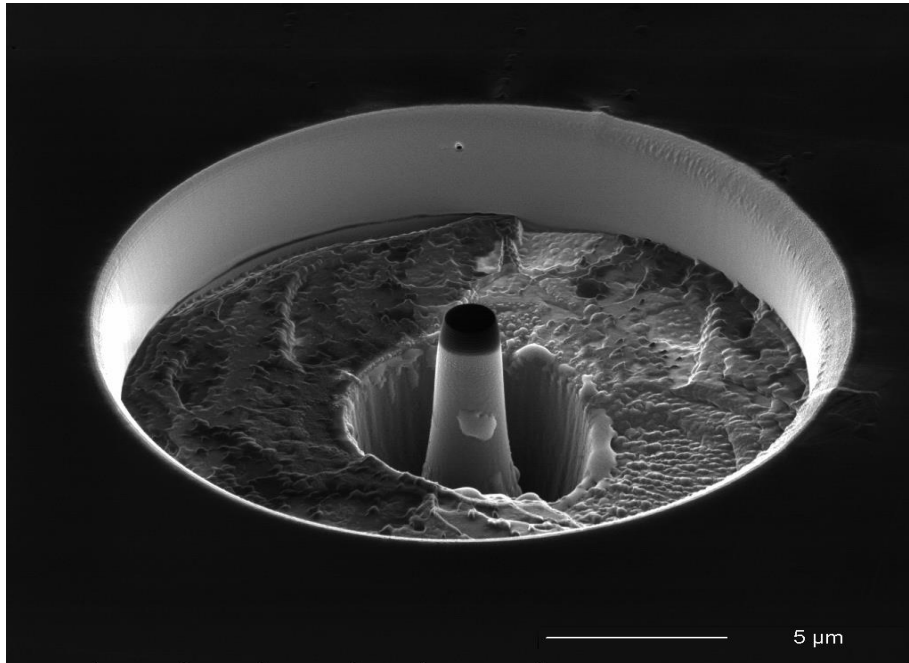
SEM se images



SEM/STEM BF images

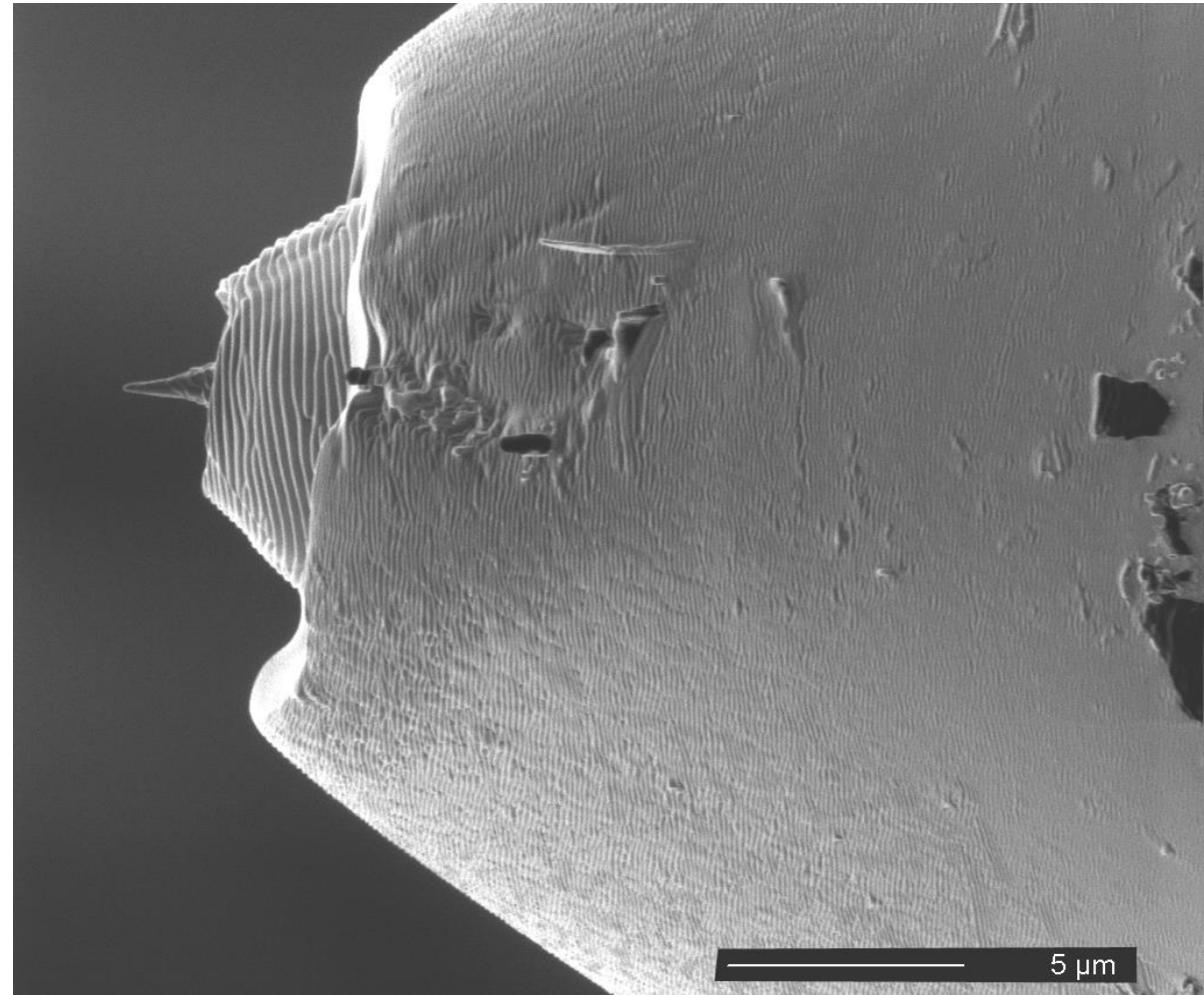
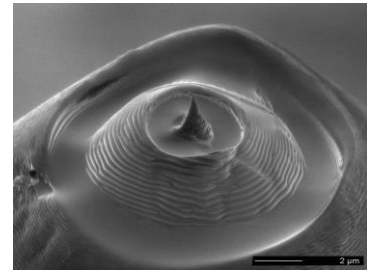
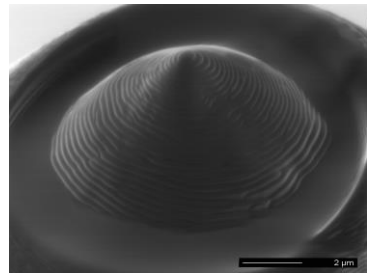
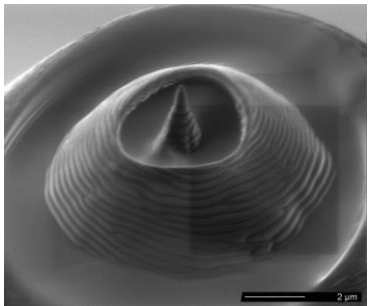
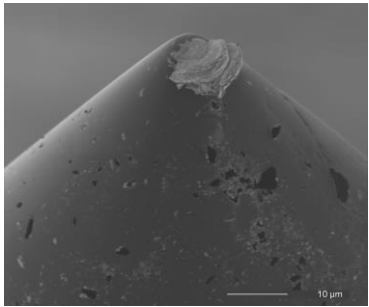
More examples:

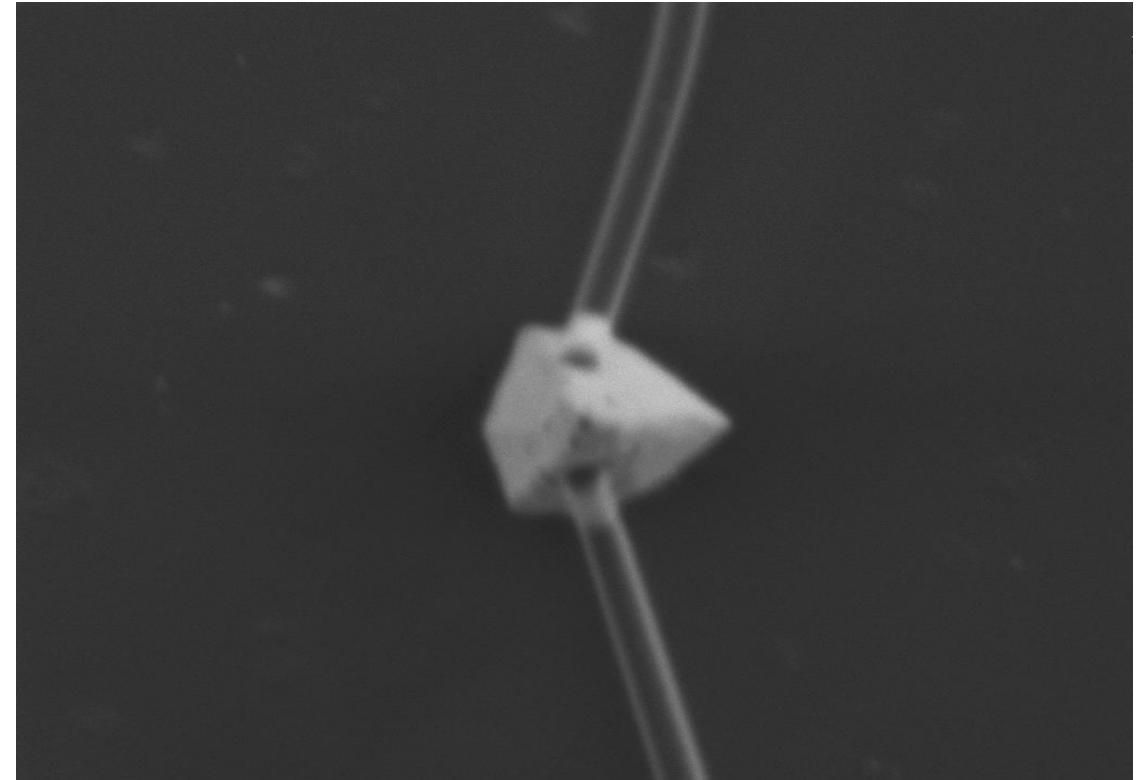
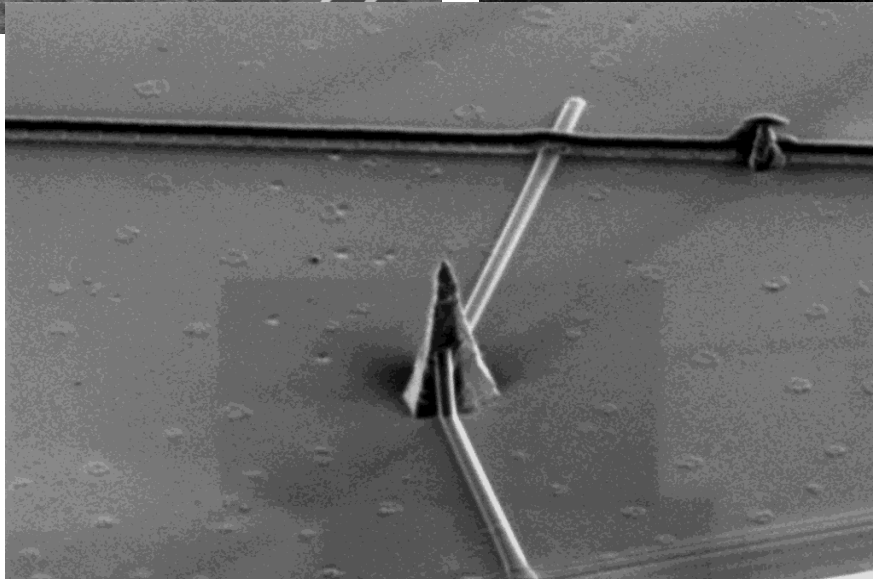
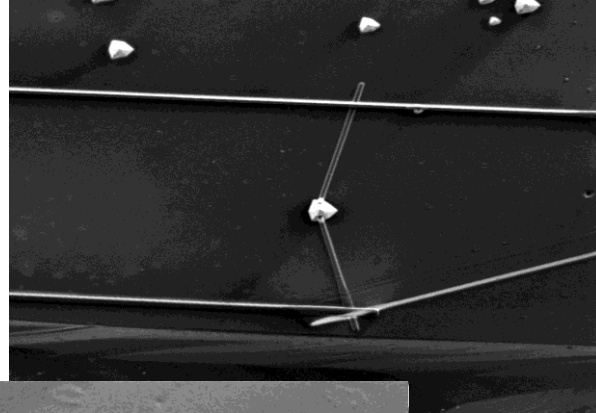
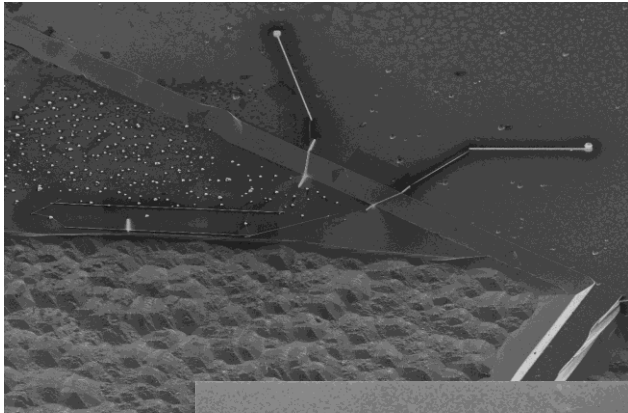
- Nano Prototyping:
- DBs milling and deposition from
Micro- to Nano-meter scale



Point source for laser-light emission produced by milling the circular structure but leaving the spot in the middle intact which then acts as a point source for laser-light emission
70 nm optical transparent SiO_x on ZnCdSe and ZnSe

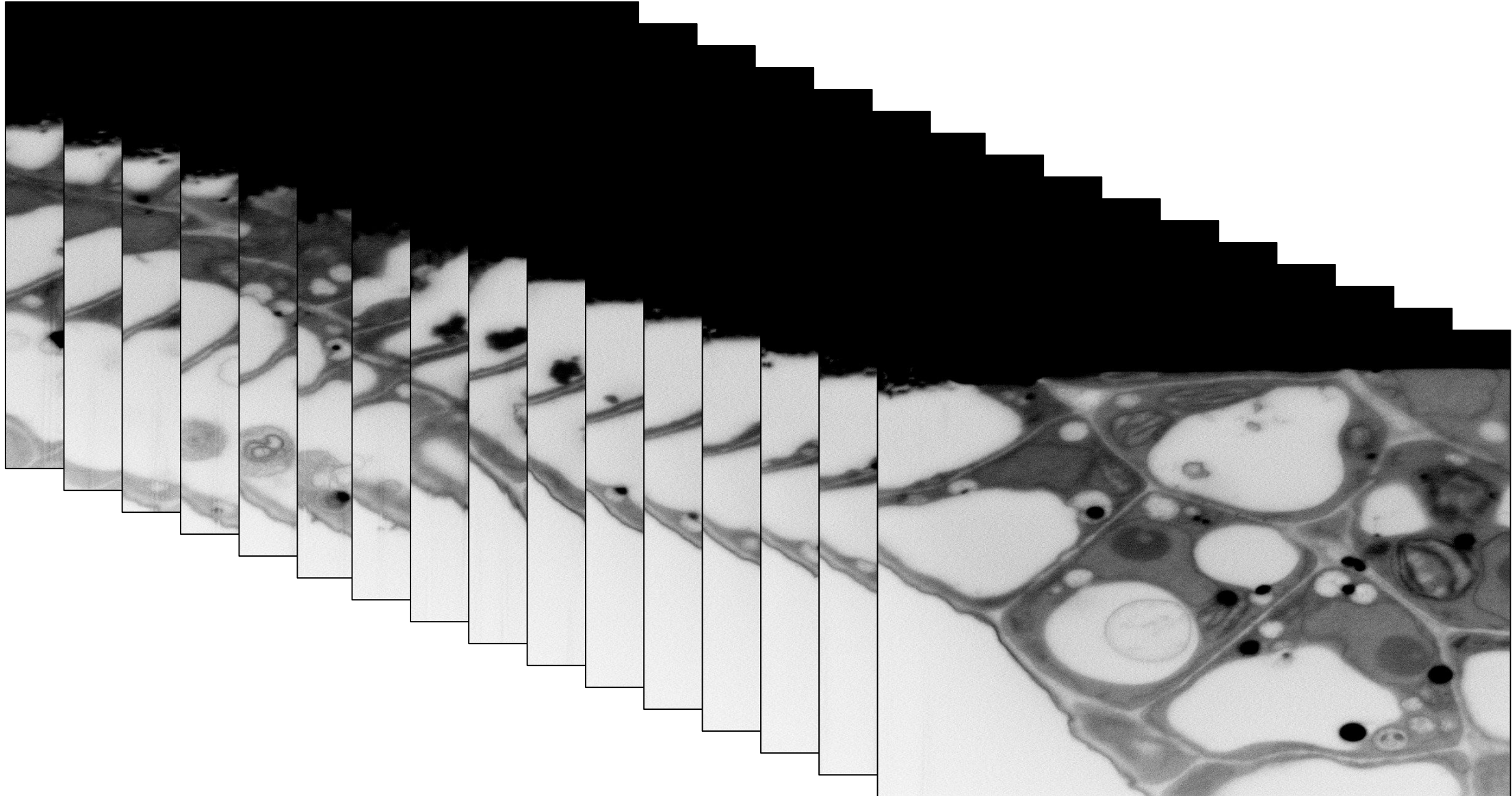
FIB Micro/Nano milling: AFM Diamond Tips

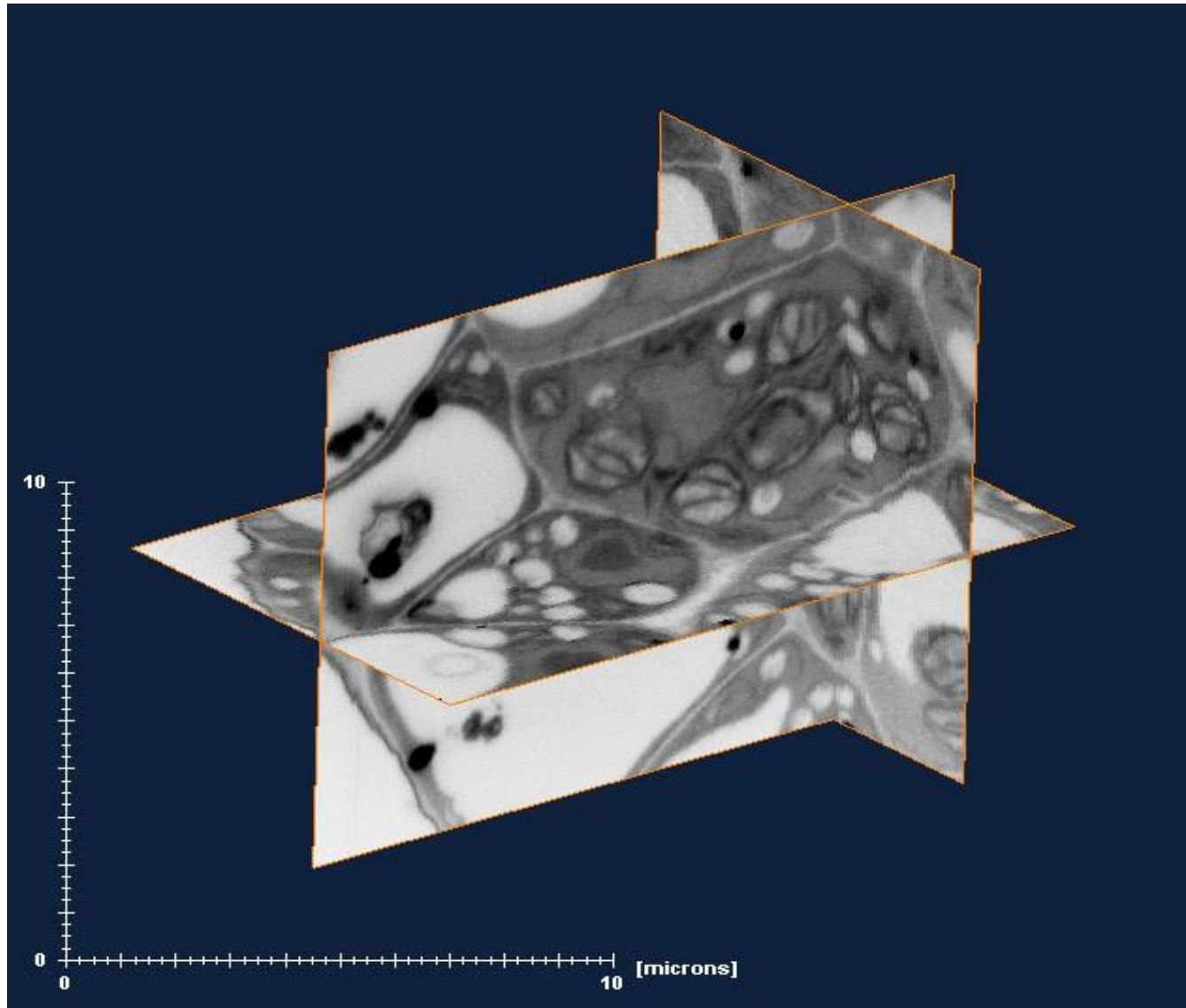




Intrinsic ferroelectrics single crystal Lithium Niobate (LiNbO_3):
Using FIB to direct write of metal line onto the side walls of the LiNbO_3

Slice and View result; Set of images





Otho-slices of an
aligned dataset
of Arabidopsis

3D reconstruction and visualization of elemental mappings and EBSD mappings

